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DESCRIPTION

ROTARY FLUID MACHINE

TECHNICAL FIELD

The present invention relates to a rotary fluid machine, in particular to measures for increasing efficiency thereof.

BACKGROUND ART

Japanese Unexamined Patent Publication No. 2000-23452 discloses an example of prior art relating to a rotary compressor used for refrigeration and air-conditioning. The rotary compressor includes, in a casing, a motor and a compressor element which receives torque of the motor via a crankshaft and compresses refrigerant gas. As shown in FIGS. **13** and **14**, the compressor element is constructed of a tubular cylinder **51** whose ends are sealed by plates **52** and **53** and a piston **54** which is arranged in the tubular cylinder and includes an integral roller **54a** and blade **54b**. In the compressor element, a compression chamber **60** is defined by the cylinder **51**, plates **52** and **53** and piston **54**. The cylinder **51** is provided with a low pressure port **56** and the upper plate **52** is provided with a high pressure port **58**. In response to the rotation of the crankshaft **59**, the piston **54** swings in the cylinder **51**. As a result, refrigerant gas sucked through the low pressure port **56** is compressed in the compression chamber **60** and the compressed refrigerant gas is discharged through the high pressure port **58**.

Problem that the Invention is to solve

In the above-described conventional rotary fluid machine, the end surfaces of the roller **54a** of the piston **54** (top and bottom end surfaces in FIG. **14**) have the same width as shown in FIG. **14**.

Specifically, the roller **54a** is fitted around an eccentric part **59a** of the crankshaft **59**. As the eccentric part **59a** has high hardness, the length of a shaft hole in the roller **54a** is shorter than the vertical length of the eccentric part **59a**. Both ends of the shaft hole of the roller **54a** are cut at a bevel, thereby defining the widths of the end surfaces of

the roller **54a**. Conventionally, the cut portions at the both ends of the roller **54** are formed the same, and therefore the both end surfaces have the same width.

Owing to this feature, there have been problems in that the degree of freedom in designing the high pressure port **58** or other is limited and compression efficiency may possibly decrease. Hereinafter, an explanation of a cause of the problems is provided.

There are several design limitations in order to maintain the compression efficiency, for example, limitations on the width in the diameter direction of the top and bottom end surfaces of the roller **54a**, i.e., a difference between inner and outer diameters of the end surfaces, the degree of eccentricity, as well as the diameter and position of the high pressure port. Referring to FIGS. **13** and **14**, the pressure in space along the inner periphery of the roller **54a** is high due to the influence of oil discharged from an oil feeding path formed in the crankshaft **59**, while the pressure in space along the outer periphery of the roller **54a** (compression chamber **60**) is low because the space is communicated with the low pressure port **56** for introducing gas. The high pressure port **58** is arranged to overlap the compression chamber **60** and not to face the space along the inner periphery of the roller **54a**. Specifically, as shown in FIG. **13**, irrespective of the position of the roller **54a**, the diameter and the position of the high pressure port are defined such that the inner peripheral edge of the roller **54a** at the top end surface does not overlap the high pressure port **58**. Thus, the space along the inner periphery of the roller **54a** and the space along the outer periphery of the roller **54a** do not communicate with each other via the high pressure port **58**.

When the roller **54a** is shared among different kinds of compressors, it is assumed that the compressors may slightly be different in the diameters and positions of the high pressure ports. In such a case, even if one compressor does not make the internal and external spaces of the roller **54a** communicate with each other, the other compressor may possibly achieve the communication when the same roller **54a** is used. When the internal and external spaces of the roller **54a** are communicated, oil discharged from the oil feeding

path in the crankshaft **59** may flow into narrow space of the compression chamber (indicated as a shaded portion in FIG. **15**) from the internal space of the roller **54a** and the oil is compressed by the revolution of the roller **54a**. Further, when the oil flows into the compression chamber **60**, the sucked gas is heated. This may deteriorate the compression efficiency.

Further, if the diameter of the high pressure port is reduced to prevent the above-described communication between the internal and external spaces, flow resistance increases. As a result, pressure loss by the high pressure port **58** increases and excessive compression is likely to occur. Thus, there is a limit on the reduction of the diameter. Further, if the high pressure port **58** is positioned away from the cylinder center in order to prevent the communication, a portion of the high pressure port **58** which lies outside the compression chamber **60** increases in area, thereby decreasing an effective area of the high pressure port **58**. In order to avoid the decrease, it is necessary to ensure the effective area of the high pressure port **58** by forming a recess in the inner peripheral surface of the cylinder **51** toward the outside to correspond to the misaligned portion of the high pressure port **58**. By so doing, however, dead volume which does not contribute to the compression increases, thereby decreasing the compression efficiency.

Thus, even if the roller **54a** is shared for the purpose of cost reduction, there is still a limit on the degree of freedom in designing the high pressure port **58**. Therefore, keeping the efficiency high may possibly be affected.

In light of the above, the present invention has been achieved. An object of the present invention is to ensure the degree of design freedom and keep the efficiency high.

DISCLOSURE OF THE INVENTION

In order to achieve the above-described object, according to the present invention, the roller **3** is arranged such that the end surfaces of the roller **3** are slidably in contact with the plates **7**, **8** and **27** and one of the end surfaces having a larger width than the width of the other end surface faces the high pressure port **10**.

Specifically, a first invention is directed to a rotary fluid machine including: a cylinder **1c** having a cylinder body **2** and plates **7** and **8** arranged at both end surfaces of the cylinder body **2**, one of the plates **7** and **8** having a high pressure port **10**; and a roller **3** placed in the cylinder **1c**, wherein the end surfaces of the roller **3** which are slidably in contact with the plates **7** and **8** of the cylinder **1c** have different widths and the roller **3** is arranged such that one of the end surfaces having a larger width than the width of the other end surface faces the high pressure port **10**.

According to a second invention relating to the first invention, the roller **3** is made of a sintered alloy.

According to a third invention relating to the first or second invention, the cylinder **1c** includes two cylinder bodies **25** and **26**. A partition plate **27** sandwiched between the cylinder bodies **25** and **26** and end plates **7** and **8** arranged outside the cylinder bodies **25** and **26** are provided as the plates. The roller **3** is arranged in each of the cylinder bodies **25** and **26** to have a difference in rotational phase. The end plates **7** and **8** are provided with high pressure ports **10**, respectively. The end surfaces of each of the rollers **3** which are slidably in contact with the plates **7** or **8** and **27** of the cylinder **1c** have different widths. Each of the rollers **3** is arranged such that one of the end surfaces having a larger width faces the end plate **7** or **8** and the other end surface having a smaller width faces the partition plate **27**.

According to a fourth invention relating to the first or second invention, the cylinder **1c** is arranged in an airtight container **9** and includes two cylinder bodies **25** and **26**. A partition plate **27** sandwiched between the cylinder bodies **25** and **26** and end plates **7** and **8** arranged outside the cylinder bodies **25** and **26** are provided as the plates. The roller **3** is arranged in each of the cylinder bodies **25** and **26**. The end plates **7** and **8** are provided with high pressure ports **10**, respectively. The end surfaces of each of the rollers **3** which are slidably in contact with the plates **7** or **8** and **27** of the cylinder **1c** are provided with cut portions **3a** and **3b**, respectively, such that one of the end surfaces facing

the end plate **7** or **8** has a larger width than the width of the other end surface facing the partition plate **27**. Gas discharged through the high pressure ports is temporarily retained in the airtight container **9**.

Specifically, according to the first invention, the cylinder body **2** is sandwiched between the plates **7** and **8** and the roller **3** is placed in the cylinder body **2**. The high pressure port **10** is formed in one of the plates **7** and **8**. The end surfaces of the roller **3** which are slidably in contact with the plates **7** and **8** have different widths. The roller **3** is arranged such that one of the end surfaces having a larger width faces one of the plates **7** and **8** having the high pressure port **10** and the other end surface having a smaller width faces the other one of the plates **7** and **8**. More specifically, the internal edge of the end surface of the roller **3** facing the high pressure port **10** is positioned more inside than the internal edge of the opposite end surface. Since the internal edge of the end surface of the roller **3** facing the high pressure port **10** is positioned more inside, even if the roller **3** is incorporated in a machine in which the high pressure port **10** is provided more inside, space along the inner periphery of the roller **3** and space along the outer periphery of the roller **3** are less likely to communicate with each other. Further, even if the roller **3** is incorporated in a compressor **1** having a larger high pressure port **10**, the internal and external spaces of the roller **3** are less likely to communicate with each other because the internal edge of the end surface of the roller **3** facing the high pressure port **10** is positioned more inside.

According to the second invention, the roller **3** is made of a sintered alloy. The roller **3** made of a sintered alloy is obtained by pouring metal powder as a molding material into a mold, followed by pressing and sintering the metal powder. In the molding of the roller, the molding material is relatively stably pressed because pressure is applied to the end surface having a larger width (larger area). In this case, the molding material is relatively easily released from the mold because the end surface having a smaller width (smaller area) is the side to be detached from the mold.

According to the third invention, the rollers **3** revolve in the cylinder bodies **25** and **26** to have a difference in rotational phase. Therefore, torque fluctuations caused in the cylinder bodies **25** and **26** are canceled. When the rollers **3** have the difference in rotational phase, different pressure fluctuations are caused in the cylinder bodies **25** and **26**. Therefore, the cylinder bodies **25** and **26** apply different pressures to the partition plate **27** arranged between the cylinder bodies **25** and **26** and the elastic deformation of the partition plate **27** is hard to reduce. In the present invention, however, since the rollers **3** are arranged such that their end surfaces having a smaller width face the partition plate **27**, the rollers **3** are less influenced even if the partition plate **27** is elastically deformed. Therefore, the rollers **3** smoothly revolve in the cylinder bodies **25** and **26**.

According to the fourth invention, gas discharged through the high pressure ports **10** is temporarily retained in the airtight container **9**. Therefore, the airtight container **9** is at a high discharge pressure. The discharge pressure is applied to the end plates **7** and **8** arranged outside the cylinder bodies **25** and **26** such that the end plates **7** and **8** are warped toward the inside of the cylinder bodies **25** and **26**. Each of the rollers **3** is arranged such that larger one of the cut portions **3a** and **3b** faces the partition plate **27**. Since the influence of the oil is greater at the end surfaces having the larger cut portions **3a** and **3b** than at the end surfaces having the smaller cut portions **3a** and **3b**, the rollers **3** are pressed toward the end surfaces having the smaller cut portions **3a** and **3b**, i.e., toward the end plates **7** and **8**. As a result, the rollers **3** suppress the warp of the end plates **7** and **8** toward the inside of the cylinder bodies **25** and **26**.

Effect of the Invention

As described above, according to the first invention, the roller **3** is arranged such that one of the end surfaces having a larger width faces one of the plates **7** and **8** having the high pressure port **10** and the other end surface faces the other one of the plates **7** and **8**. Therefore, the internal and external spaces of the roller **3** are less likely to communicate with each other. As a result, even if the roller **3** is shared, there is no need of taking

measures of reducing the diameter of the high pressure port to avoid the communication. Thus, the diameter of the high pressure port is determined without limitations on the degree of freedom and an increase in pressure loss by the high pressure port **10** is prevented.

Further, as the need of taking measures of shifting the high pressure port **10** outside to avoid the communication is eliminated, the position of the high pressure port **10** is determined without limitations on the degree of freedom.

Further, since the portion of the high pressure port **10** lying outside the compression chamber **22** is reduced in area, even if a recess is formed in the inner peripheral surface of the cylinder **2** to ensure the effective area of the high pressure port **10**, the size of the recess is kept small. Thus, dead volume which does not contribute to the compression is minimized.

Therefore, according to the present invention, the degree of design freedom is ensured, the increase in pressure loss is avoided and the dead volume is prevented from increasing as possible. Thus, the compression efficiency is maintained high.

According to the second invention, the roller **3** is made of a sintered alloy. In the molding of the roller **3**, the molding material is relatively stably pressed because pressure is applied to the end surface having a larger width (larger area). In this case, the molding material is relatively easily released because the end surface having a smaller width (smaller area) is the side to be detached from the mold.

According to the third invention, the rollers **3** are arranged such that the rollers **3** have a difference in rotational phase and their end surfaces having a smaller width face the partition plate **27**. Therefore, according to the present invention, torque fluctuations caused by the two cylinder bodies **25** and **26** included in the rotary fluid machine **1** are reduced and the influence by the elastic deformation of the partition plate **27** is also reduced. Thus, the rollers are operated with stability in the cylinder bodies **25** and **26**.

According to the fourth invention, gas discharged through the high pressure ports

10 is temporarily retained in the airtight container **9** and the rollers **3** are arranged such that the end surfaces having the smaller cut portions face the end plates **7** and **8**. Therefore, according to the present invention, leakage of the gas from the cylinder bodies **25** and **26** through gaps between the rollers **3** and the end plates **7** and **8** is suppressed.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a sectional view illustrating the overall structure of a rotary fluid machine according to Embodiment 1 of the present invention.

FIG. **2** is a top view illustrating a cylinder body and a piston according to Embodiment 1 of the present invention.

FIG. **3** is a sectional view schematically illustrating a major part of Embodiment 1 of the present invention.

FIGS. **4A** and **4B** are views illustrating the piston according to Embodiment 1 of the present invention.

FIG. **5** is a view corresponding to FIG. **1** according to Embodiment 2 of the present invention.

FIG. **6** is a plan view illustrating a middle plate.

FIG. **7** is a view corresponding to FIG. **2** according to Embodiment 2 of the present invention.

FIG. **8** is a view illustrating how a front head and a rear head deform.

FIG. **9** is a view illustrating the distribution of hydraulic pressure applied to the roller.

FIG. **10** is a view illustrating part of a section of the middle plate.

FIG. **11** is a view corresponding to FIG. **2** illustrating another embodiment.

FIG. **12** is a view corresponding to FIG. **1** illustrating still another embodiment.

FIG. **13** is a view corresponding to FIG. **2** illustrating a conventional compressor.

FIG. **14** is a view corresponding to FIG. **3** illustrating the conventional compressor.

FIG. **15** is a view illustrating a partial enlargement of FIG. **13**.

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, a detailed explanation of embodiments of the present invention will be provided with reference to the drawings.

(EMBODIMENT 1)

As shown in FIG. **1**, a rotary fluid machine according to Embodiment 1 of the present invention is constructed as, for example, a rotary compressor **1** which is incorporated in a refrigeration machine (not shown) and includes in an airtight container **9** a compressor mechanism **1a** and a drive mechanism **1b** for driving the compressor mechanism **1a**.

As shown in FIGS. **2** and **3**, the compressor mechanism **1a** includes a cylinder **1c** and a piston **5** arranged in the cylinder **1c**. The cylinder **1c** includes a tubular cylinder body **2** and a front head **7** and a rear head **6** as plates arranged on the top and bottom end surfaces of the cylinder body **2**.

The piston **5** is arranged in the cylinder body **2** and formed by integrating a cylindrical roller **3** and a flat blade **4** extending outward in the radius direction from the roller **3**. The piston **5** is made of a sintered alloy. Specifically, in Embodiment 1, the roller **3** and the blade **4** are made of the sintered alloy.

The outer periphery of the cylinder body **2** is fixed onto the inner periphery of the airtight container **9**. The cylinder body **2** is provided with a bushing hole **2a** formed to have an opening at the inner peripheral surface of the cylinder body **2** and a blade hole **2b** continuous from the bushing hole **2a**. A pair of bushings **6** are arranged in the bushing hole **2a**. The bushings **6** are halves of a columnar component and rotatably fitted in the bushing hole **2a**. The blade **4** is slidably inserted between the bushings **6**.

The front head **7** and the rear head **8** are fixed together with bolts with the cylinder body **2** sandwiched therebetween. As a result, closed space **22** is defined by the front head **7**, rear head **8**, roller **3** and cylinder body **2**. The closed space is a compression chamber **22**. The compression chamber **22** is divided by the blade **4** into a high pressure

chamber **22a** communicated with a high pressure port **10** and a low pressure chamber **22b** communicated with a low pressure port **23** to be described later.

The front head **7** is positioned higher than the rear head **8**. The front head **7** is provided with a high pressure port **10** which extends in the vertical direction to communicate with the compression chamber **22** and the airtight container **9** under a certain pressure condition. A discharge valve (not shown) is provided at the top end of the high pressure port **10**. The discharge valve is opened when the pressure in the cylinder body **2** exceeds the pressure in the airtight container **9**, i.e., the pressure around the compressor mechanism **1a**. At the top end of the airtight container **9**, a discharge pipe **11** is inserted. Specifically, the rotary compressor **1** according to Embodiment 1 is constructed as a so-called high pressure dome compressor in which refrigerant gas discharged from the compressor mechanism **1a** through the high pressure port **10** is temporarily retained in the airtight container **9**.

The cylinder body **2** is provided with a low pressure port **23** which is formed to penetrate the cylinder body **2** in the radius direction. A suction pipe **21** penetrating the airtight container **9** is inserted into the low pressure port **23** and the internal end of the low pressure port **23** is opened at the inner peripheral surface of the cylinder body **2** as a suction port **20**. The suction pipe **21** is connected to an accumulator **40** to let the refrigerant gas flow in.

The roller **3** is in the cylinder form as described above. As schematically shown in FIGS. **4A** and **4B**, the inner peripheral edges at both ends of the roller **3** in the axis direction thereof are cut at a bevel to provide cut portions **3a** and **3b**. Specifically, the top and bottom end surfaces of the roller **3** slidably contacting the heads **7** and **8** are assumed as surface M and surface N, respectively. The top cut portion **3a** sloped toward the surface M and the cut portion **3b** sloped toward the surface N have substantially the same angle of inclination with respect to the surface M or N. The cut portions **3a** and **3b** are different in size, i.e., the height from the end surface and the width in the radius direction.

As shown in FIG. **4B**, the height of the bottom cut portion **3b** from the surface N is larger than the height of the top cut portion **3a** from the surface M and the width of the bottom cut portion **3b** is larger than the width of the top cut portion **3a**.

Assuming that the outer diameter of the surfaces M and N is D, the inner diameter of the surface M is D_M and the inner diameter of the surface N is D_N, the width of the surface M, i.e., the width in the radius direction obtained by subtracting the inner diameter D_M of the surface M from the outer diameter D of the surface M, is represented as $(D-D_M)/2$. Likewise, the width of the surface N, i.e., the width in the radius direction obtained by subtracting the inner diameter D_N of the surface N from the outer diameter D of the surface N, is represented as $(D- D_N)/2$. Since the bottom cut portion **3b** is formed larger than the top cut portion **3a** as described above, the width of the surface M is larger than the width of the surface N. In other words, the inner diameter D_M of the surface M is smaller than the inner diameter D_N of the surface N.

The roller **3** is arranged such that the surface M having the larger width faces the bottom surface of the front head **7** having the high pressure port **10**. Specifically, the top end surface of the roller **3** facing the high pressure port **10** has a larger width than the width of the other end surface (bottom end surface). However, unlike Embodiment 1, the roller **3** may be arranged such that the width of the bottom end surface has a larger width than the width of the top end surface.

The roller **3** made of a sintered alloy is obtained by pouring metal powder as a molding material into a mold (not shown), followed by pressing and sintering the metal powder. Specifically, the mold has a convex portion in the conical form at the bottom thereof for forming the beveled inner peripheral edge at the bottom end surface of the roller **3**. Further, a pressing member (not shown) for pressing the molding material in the mold is provided with a convex portion for forming the beveled inner peripheral edge at the top end surface of the roller **3** and a cavity of the roller **3**. The molding material poured into the mold is heated while it is pressed by the pressing member. In the mold,

the roller **3** is formed with the bottom end surface facing the bottom of the mold. Thereafter, the molding material is released from the mold. In the molding of the roller **3**, one of the end surfaces of the roller **3** pressed by the pressing member is given with a larger width, while the other end surface facing the bottom of the mold is given with a smaller width.

As shown in FIG. **1**, the drive mechanism **1b** is a motor and includes a stator **13**, a rotor **12** and a crankshaft **14**. The stator **13** is fixed to the airtight container **9**. The rotor **12** is arranged inside the stator **13** in a rotatable manner and the crankshaft **14** is inserted into the rotor **12**. The crankshaft **14** is integrated with an eccentric part **16**. The roller **3** is fitted around the eccentric part **16** such that the roller **3** revolves. The drive mechanism **1b** is not always limited to the motor.

An oil tube **18** for sucking refrigerator oil retained in an oil retainer **19** arranged at the bottom of the airtight container **9** is fixed to the bottom end of the crankshaft **14**. An oil feeding path **15** for distributing sucked oil is formed in the crankshaft **14**. The oil feeding path **15** is communicated with an oil feeding path outlet **17** which is opened at the eccentric part **16** or a bearing such that the refrigerator oil in the oil retainer **19** is guided to the sliding parts.

Now, an explanation of how the rotary compressor **1** of the present embodiment works will be provided.

The crankshaft **14** is driven by the drive mechanism **1b** to rotate, thereby making the piston **5** swing within the cylinder body **2**. As a result, refrigerant gas is sucked into the cylinder body **2** from the outside of the compressor **1** through the suction pipe **21**. The piston **5** swings in the cylinder body **2** while the crankshaft **14** rotates. When the suction port **20** of the cylinder body **2** is closed by the outer peripheral surface of the roller **3**, the step of sucking the refrigerant gas into the cylinder body **2** is finished. At this time, a compression chamber **22** is formed in the cylinder body **2**. After the suction step, in the compression chamber **22**, the process proceeds to a compression step as the piston **5**

swings, and at the same time, another compression chamber **22** is formed near the suction port **20** and the refrigerant gas flows into the new compression chamber **22** in the same manner as described above.

As the crankshaft **14** rotates, the compression chamber **22** in the compression step decreases its volume, thereby gradually increasing the pressure in the cylinder body **2**. When the pressure in the cylinder body **2** exceeds the pressure in the airtight container **9**, i.e., the pressure around the compression mechanism **1a**, the process proceeds to a discharge step. In the discharge step, the discharge valve begins to open due to the difference between the pressure in the airtight container **9** and the pressure in the compression chamber **22**. Then, the refrigerant gas compressed in the compression chamber **22** begins to be discharged into the airtight container **9** through the high pressure port **10**. As the crankshaft **14** further rotates, the difference in pressure increases and the discharge valve is lifted more, thereby discharging the compressed gas. Then, as the pressure difference between the airtight container **9** and the compression chamber **22** decreases, the discharge valve is lifted less. When the volume in the compression chamber **22** becomes minute, the discharge step is finished. The above-described series of steps are carried out by the rotation of the crankshaft **14**. The refrigerant gas discharged from the compression chamber **22** is emitted out of the compressor mechanism **1a**, temporarily retained in the airtight container **9**, and then discharged out of the compressor **1**.

Next, an explanation of oil flow will be provided. Refrigerator oil retained at the bottom of the compressor mechanism **1a** flows upward within the crankshaft **14** due to the difference between the pressure at the oil feeding path outlet **17** formed in the crankshaft **14** and the pressure in the airtight container **9**. Then, the oil flow is divided to supply the oil to the sliding parts, i.e., the rear head **8**, eccentric part **16** and front head **7**. Thus, a fine gap between the inner peripheral surface of the cylinder body **2** and the outer peripheral surface of the piston **5**, a fine gap between the top end surface of the piston **5**

and the bottom end surface of the front head **7** and a fine gap between the bottom end surface of the piston **5** and the top end surface of the rear head **8** are sealed with the oil.

Hence, in Embodiment 1, the following effects are achieved. In Embodiment 1, the roller **3** is arranged such that the end surface having a larger width (surface M) faces the bottom end surface of the front head **7**. As described above, the high pressure port **10** is opened at the bottom end surface of the front head **7**. Therefore, as compared with the structure in which the roller end surface having a smaller width faces the front head **7**, it is possible to increase the diameter of the high pressure port **10** and arrange the high pressure port **10** closer to the center of the cylinder body **2**, i.e., closer the crankshaft **14**.

In general, the high pressure port **10** is always arranged to be more outside than the inner peripheral edge of the top end surface of the roller **3**. In the rotary compressor **1** according to Embodiment 1, the roller **3** is arranged such that the end surface facing the high pressure port **10** (closer to the front head **7**) has a larger width than the end surface facing the rear head **8**. Accordingly, the inner diameter D_M of the end surface closer to the front head **7** is smaller than the inner diameter D_N of the end surface closer to the rear head **8**. Therefore, even if the roller **3** is incorporated in the compressor **1** having a larger high pressure port **10**, the space inside the roller **3** and the space outside the roller **3** are less likely to communicate with each other via the high pressure port **10**.

Further, even if the thus configured roller **3** is incorporated in the compressor **1** having the high pressure port **10** which is positioned more inside, the space inside the roller **3** and the space outside the roller **3** are less likely to communicate with each other via the high pressure port **10**.

Therefore, even if the roller **3** is shared, there is no need of taking measures of reducing the diameter of the high pressure port to avoid the communication. Accordingly, the diameter of the high pressure port is determined without limitations on the degree of freedom and a pressure loss by the high pressure port **10** is prevented from increasing.

Further, since there is no need of taking measures of shifting the high pressure port

10 outside to avoid the communication, the position the high pressure port is determined without limitations on the degree of freedom.

Still further, the portion of the compression chamber **22** lying outside the compression chamber **22** is reduced in area. Therefore, even if a recess is formed in part of the inner peripheral surface of the cylinder body **2** to ensure the effective area of the high pressure port **10**, the recess is kept small and therefore dead volume which does not contribute to the compression is minimized.

Thus, according to the present invention, the degree of design freedom is ensured, the increase in pressure loss is prevented and the dead volume is prevented from increasing, thereby keeping the compression efficiency high.

According to Embodiment 1, the piston **5**, i.e., the roller **3** and the blade **4** are made of a sintered alloy. The roller **3** made of the sintered alloy is obtained by pouring metal powder as molding material into a mold, followed by pressing and sintering the metal powder. In the molding of the roller, the top and bottom end surfaces are formed to have different widths to provide the end surfaces different areas. Therefore, the molding material is pressed stably by applying pressure from the end surface having a larger width (larger area). In this case, the molding material is easily released from the mold because the end surface having a smaller width (smaller area) is the side to be detached from the mold.

(EMBODIMENT 2)

FIG. **5** shows a rotary fluid machine according to Embodiment 2 of the present invention. In this figure, the same components as those of Embodiment 1 are indicated by the same reference numerals and a detailed explanation thereof is omitted. In Embodiment 2, the present invention is applied to a swing piston compressor **1** having two or more cylinder bodies **25** and **26**.

A cylinder **1c** of a compressor mechanism **1a** includes two cylinder bodies **25** and **26** which are aligned in the direction of extension of a crankshaft **14**, i.e., the vertical

direction.

A front head **7** and a rear head **8** function as end plates, respectively. The front head **7** is arranged on the first cylinder body **25** above a second cylinder body **26** and the rear head **8** is arranged below the second cylinder body **26** below the first cylinder body **25**. A middle plate **27** is arranged between the first cylinder body **25** and the second cylinder body **26** as a partition plate. In the center portion of the middle plate **27**, a through hole **27a** for passing the crankshaft **14** through is formed.

The front head **7**, first cylinder body **25**, middle plate **27**, second cylinder body **26** and rear head **8** are arranged in this order and bolted together. The crankshaft **14** penetrates the heads **7** and **8**, cylinder bodies **25** and **26** and middle plate **27**.

A first piston **33** and a second piston **34** are arranged in the first and second cylinder bodies **25** and **26**, respectively. The pistons **33** and **34** have the same structure as the piston **5** according to Embodiment 1. In Embodiment 2, the front head **7**, first cylinder body **25**, first piston **33** and middle plate **27** form a first compression chamber **35**. Further, the rear head **8**, second cylinder body **26**, second piston **34** and middle plate **27** form a second compression chamber **36**.

The front head **7** and the rear head **8** are provided with high pressure ports **10**, respectively, as shown in FIGS. **7** and **8**. A top muffler **30** is attached to the front head **7** and a bottom muffler **31** is attached to the rear head **8**.

A roller **3** of the first piston **33** is arranged such that the top end surface having a larger width faces the front head **7** and the bottom end surface having a smaller width faces the middle plate **27**. Specifically, the roller **3** in the first cylinder body **25** is configured such that a cut portion **3a** at the top end surface is smaller than a cut portion **3b** at the bottom end surface. A roller **3** in the second piston **34** is arranged such that the bottom end surface having a larger width faces the rear head **8** and the top end surface having a smaller width faces the middle plate **27**. Specifically, the roller in the second cylinder body **26** is configured such that a cut portion **3b** at the bottom end surface is smaller than a

cut portion **3a** at the top end surface. In other words, the top and bottom rollers **3** are arranged such that the relationship between the widths of the top and bottom end surfaces (the sizes of the cut portions **3a** and **3b**) is opposite to each other.

The crankshaft **14** has two eccentric parts **16** corresponding to the number of the cylinder bodies **25** and **26**. The eccentric parts **16** are arranged to have a difference in rotational phase of π radian (180°) as shown in FIG. **7**. The phase difference of π radian makes it possible to cancel torque fluctuations caused by the compression of the refrigerant gas. FIG. **7** shows the first cylinder body **25** when the suction step has been finished. At this time, a first compression chamber **35** at a suction pressure is provided in the first cylinder body **25**. In the second cylinder body **26**, compression is carried out and a high pressure chamber at a discharge pressure and a low pressure chamber at a suction pressure are provided.

In the rotary fluid machine **1** according to Embodiment 2, the above-described series of steps including compression and discharge are carried out by the pistons **33** and **34** while the difference in rotational phase of π radian is maintained. The refrigerant gas compressed in the first compression chamber **35** is discharged into the top muffler **30** through the high pressure port **10**. The refrigerant gas compressed in the second compression chamber **36** is discharged into the bottom muffler **31** through the high pressure port **10** and then guided to the top muffler **30** through a discharge path which is not shown in the figure. The refrigerant gas in the top muffler **30** is temporarily retained in the airtight container **9** and then discharged out of the compressor **1**.

In the state shown in FIG. 7, the first compression chamber **35** is at a suction pressure. In the second compression chamber **36**, the high pressure chamber is at a discharge pressure, while the low pressure chamber is at a suction pressure. Therefore, different pressures are applied from above and below to the middle plate **27** between the top and bottom compression chambers **35** and **36**, thereby elastically deforming the middle plate **27**. As described above, however, the top and bottom rollers **3** are arranged such

that the larger ones of their cut portions **3a** and **3b** face the middle plate **27**. Therefore, even if the middle plate **27** is elastically deformed, the rollers **3** are less likely to be affected and operated smoothly.

To the front head **7**, the discharge pressure in the airtight container **9** is applied from above and the suction pressure in the first compression chamber **35** is applied from below. Therefore, as shown in FIG. **8**, the front head **7** is warped at the center toward the inside of the first cylinder body **25**. Further, to the rear head **8**, the discharge pressure in the airtight container **9** is applied from below and the pressure in the second compression chamber **36** is applied from above. Therefore, as shown in the same figure, the rear head **8** is warped at the center toward the inside of the second cylinder body **26**.

As shown in FIG. **9**, one of the end surfaces of each of the rollers **3** having the larger one of the cut portions **3a** and **3b** has a larger area for receiving hydraulic pressure than the other end surface having the smaller one of the cut portions **3a** and **3b**. Therefore, pressure is likely to be applied in the direction toward the smaller ones of the cut portions **3a** and **3b**. Therefore, in Embodiment 2, the roller **3** of the first cylinder body **25** is pressed upward and the roller **3** of the second piston **34** is pressed downward. As a result, the roller **3** of the first piston **33** suppresses the elastic deformation of the front head **7** caused by the above-described difference in pressure, while the roller **3** of the second piston **34** suppresses the elastic deformation of the rear head **8** due to the pressure difference. This makes it possible to suppress expansion of gaps between the rollers **3** and the heads **7** and **8**. Thus, since the rollers **3** are arranged such that the larger ones of the cut portions **3a** and **3b** face the middle plate **27**, the warp of the front and rear heads **7** and **8** caused by the discharge pressure in the airtight container **9** is suppressed. As a result, leakage of the refrigerant gas in the compression chambers **35** and **36** from the gaps between the rollers **3** and the heads **7** and **8** is suppressed.

When the through hole **27a** is formed in the middle plate **27**, the peripheral edge of the through hole **27a** is likely to be slightly plastically deformed toward one side in the

direction of penetration as shown in FIG. **10**. However, since the rollers **3** are arranged such that the larger cut portions **3a** and **3b** face the middle plate **27** and the smaller cut portions **3a** and **3b** face the heads **7** and **8**, the plastically deformed peripheral edge of the through hole **27a** of the middle plate **27** is prevented from interfering with the roller **3**. Thus, the pistons **33** and **34** are operated more smoothly, thereby maintaining the compression efficiency high.

Other structures and effects are the same as those of Embodiment 1 described above.

(OTHER EMBODIMENTS)

In the above-described embodiments, the roller **3** and the blade **4** are integrated to provide the swing piston **5**, **33** or **34**. However, the integral piston may be replaced by a piston **5** which includes a separate roller **3** and blade **4**. In this case, the blade **4** is pressed onto the roller **5** by a biasing means **4a**. The roller **3** revolves along the inner peripheral surface of the cylinder body **2** and the blade **4** reciprocates in this state in response to the movement of the roller **3**.

In the above-described embodiments, the cylinder bodies **2**, **25** and **26** and the rollers **3** are shaped to have circular sections, respectively. However, this is not limitative. For example, the cylinder body **2** and the roller **3** may be formed to have oval sections such as almost egg-shaped sections as shown in FIG. **12**.

INDUSTRIAL APPLICABILITY

As described above, the rotary fluid machine according to the present invention is effective for enhancing efficiency. In particular, the present invention is suitable when the roller is shared.